

This summary will provide an overview of the current state of adapted computer technology, its practicality in the educational and job environment, legal implications and future trends.

The term "adapted computer technology" refers to any hardware or software system which, when used in conjunction with a microcomputer, provides systems access to disabled persons. The primary disability groups most likely to benefit from access to adapted computer technology are visually, orthopedically and learning impaired individuals.

In the current system of communication between people and computers, screen and keyboard are the primary channels of information exchange. Persons with disabilities, low vision or limited fine motor control, for example, find these channels of communication partially or totally obstructed. Traditional responses to this problem have typically involved specialized mechanical devices, exotic software or customized computer systems. Few of these solutions have proven effective in either the educational or work setting. Lack of cost effectiveness, steep learning curves and limited user productivity have rendered the implementation of such devices more a gesture of good will than a serious attempt to provide meaningful computer access in a process leading to productive, professional employment for disabled persons. Given the degree of technological sophistication previously available in the area of adapted computer access, this was probably all that could be reasonably expected under the auspices of education's mandate to provide "reasonable accommodation" and industry's affirmative action/equal opportunity employment guidelines.

Over the last two years, advances in microcomputer technology and the art/science of computer programming have given rise to a new generation of methods for providing computer access to disabled

ES.1

persons. A revolution has taken place in the efficiency, practicality and cost effectiveness of adapted computer technology. Most adaptations now exist as specialized computer programs rather than mechanical devices or customized computer systems. The practical results of these innovative new access technologies will have significant impact on the future of disabled individuals and on education and business.

Because this new generation of adapted computer access technologies is primarily software based, it allows full and unencumbered access to the complete range of commercially available software. In practical terms, this means that, for the most part, education and business can accommodate the special access needs of disabled computer users without modifying core curriculum software or business applications programs. Because adaptations are based in software, costs are dramatically reduced. Typical software adaptations cost one-half to two-thirds less than traditional hardware adaptations while providing significantly improved computer access and ease of use. The implementation of these new access technologies is taking place in many broad and diverse areas of both the educational and business community. Such educational institutions as the California community college system, University of California at Davis, Yale, Stanford and many other colleges and universities across the nation are actively involved in improving computer access for their disabled students through the use of adapted computer technology.

A number of major computer manufacturers have made a strong commitment to the future of adapted computer technology. Digital Equipment Corporation, IBM and Apple Computer Corporation all have divisions dedicated to providing computer access for disabled individuals. **IBM, through its Office of Product Initiatives for the Disabled**, is actively sponsoring, developing and encouraging the manufacture of prod-

ES.2

ucts which provide enhanced computer access for persons with disabilities. Apple Computer Corporation's Office of Special Education is dedicated to providing information about adapted computer technology to both education and industry, and has set new industry standards in access accomodation by including access programs for individuals with low vision, the deaf or hard-of-hearing, and the orthopedically disabled, as a part of the operating system for Macintosh computers.

In California, the State Department of Rehabilitation expressed its commitment to the future of adapted computer technology through a series of grants to the Community College Foundation totaling more than \$5.5 million dollars. In cooperation with the California Community Colleges Chancellor's Office and participating colleges, these grants have established adapted computer technology centers at 51 of California's 106 community colleges, three California State University campuses, the University of California at Davis and other educational institutions across the state.

ES.3

Although there are probably many effective ways to introduce adapted computer technology into a post-secondary educational setting, the California model has been in place for four years and provides an empirical, tested framework from which to begin.

The basic assumption of this model is that disabled students are presently, or will become, fully functional members of the community of students on campus. They will enroll in the same classes, be held fully accountable for academic standards and will progress towards graduation and employment. The purpose of this model is to provide functional computer access so that disabled students can: (1) fully participate in courses or career paths in which computers play an integral part and (2) avail themselves of the special benefits provided by computer access to students in general (i.e., word processing, research, computer assisted instruction, etc.).

ES.4

In order to provide disabled students with training and experience in the use of computer adaptations, the California model establishes on campus a facility called The High-Tech Center for the Disabled. This facility is staffed by an Adapted Computer Technologies specialist and instructional aides. The Center offers specialized courses in the use of adapted access technologies appropriate to a particular student's disability. Generally, the use of appropriate adaptations is taught within the context of word processing. Upon achieving competency with his/her appropriate adaptation, the student may confidently enroll in courses which require computer access or use existing campus computer facilities. The underlying assumption of the California model is that a full range of adaptations identical to those learned in the High-Tech Center will be available at each major computer facility on campus. Where this is not possible, the High-Tech Center may also function as a resource center providing computer access for daily student needs.

Adapted computer technology functions most effectively with MS DOS based PC computers (i.e., IBM PS/2s, IBM PCs, AT&T PCs, Compaqs, HP Vectras, PC clones, etc.), Macintosh series computers, and to a lesser extent with Apple II series computers. This limitation in Apple II series computers is due in large measure to slow processing speed, the operating system architecture and constraints imposed by the characteristics of the processor chip used. The Macintosh computer is potentially capable of supporting an elegant array of adapted computer technologies. Although few adaptations currently exist for the Macintosh, those that do are quite good, and more will undoubtedly become available.

When used as a terminal in a mainframe or mini-computer network, PCs will generally support adaptations while running in terminal emulation mode under

MS DOS. This is an important consideration since software based adapted computer technology is virtually nonexistent for mini and mainframe computer systems using dumb terminals (DEC VT-240s or IBM 3270s, for example).

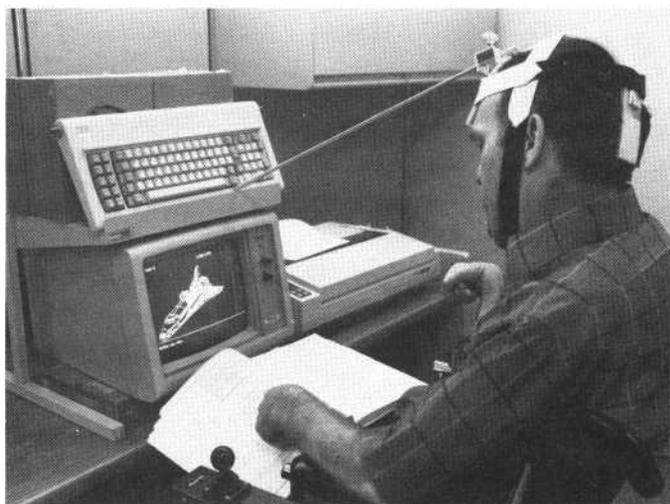
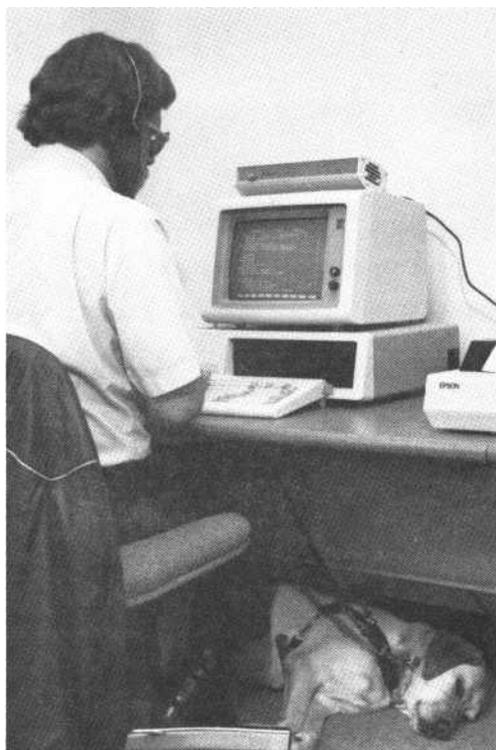
Adaptations for blind computer users work exceptionally well on PC computers, moderately well on Apple He's, and will soon be available for the Apple Macintosh. Systems for blind computer users are composed of two parts: (1) specialized software capable of "reading" text displayed on the computer screen and (2) speech synthesizers capable of "speaking" what is being "read." There are a variety of screen reading programs and speech synthesizers available. DECTalk, manufactured by Digital Equipment Corporation, is generally considered to be the best speech synthesizer currently manufactured. Blind computer users can be quite successful with tasks which involve text and/or numbers.

ES.S

Successful applications might include but are in no way limited to accounting, spreadsheets, database management, word processing, computer programming and data entry. Computer applications which depend heavily on graphic presentations (i.e., computer assisted design, statistical information displayed as charts and graphs, etc.) remain a problem as the present generation of screen reading programs provide no methods for interpreting graphic displays.

Adaptations for individuals with low vision work very well on the PC and Macintosh computers. Good low vision adaptations also exist for the Apple II series and many "dumb" computer terminals although they are hardware based and rather expensive. Low vision adaptations are available for both the PC and Macintosh computers which provide magnification of both text and graphics on the computer screen. Low vision adaptations for the Apple II series or other computer terminals accomplish much the same thing but do so





by presenting the enlarged image on a separate display monitor. When provided with appropriate adapted computer technology, individuals with low vision can enjoy full access to campus-wide computer resources.

Adaptations for individuals with mild to severe orthopedic disabilities exist and work well on PC, Apple II series and Macintosh computers, although the most sophisticated adaptations are still only available for the PC. These adaptations are primarily concerned with reducing the difficulty experienced by individuals with missing limbs or limited fine motor control in accessing the keyboard. Simply overcoming keyboarding difficulties, however, is not enough to provide effective computer access for moderately to severely orthopedically disabled persons. Another very significant area of adaptive intervention concerns typing speed. In order to be competitive in either the educational or job environment, the orthopedically disabled individual must be able to produce written material quickly. "Smart" word processing systems available for PC computers use artificial intelligence technologies to anticipate and predict word choices based on minimum text input. Using these systems, individuals with significant orthopedic disabilities can increase their typing rate by as much as 75%.

ES.8

Adaptations for individuals with learning disabilities, primarily visual and auditory processing deficits, can be very successfully introduced in both the PC and Macintosh environments, and used with moderate success on Apple systems. A visual processing deficit frequently manifests itself as a chronic, intermittent inability to receive and/or express written information in an organized and sequential manner. For a student in post-secondary education or an employee in a text-oriented job setting, the effects of this disability can be devastating. Using a combination of adaptations including smart word processors, real-time spell

checkers, screen reading systems and advanced speech synthesizers, an adapted writing environment can be created which is auditorially rather than visually oriented. In this environment, the user can hear what he/she has written and so transfer the error identification/correction process to an auditory mode where it can proceed unobstructed by the effects of the visual processing disability.

Just as a mechanical prosthesis becomes a natural extension of its wearer, compensating for a limb lost to accident or injury and restoring the ability to carry out the normal activities of daily living, so a computer adaptation quickly becomes an extension of its user, an electronic prosthesis effortlessly compensating for and restoring his/her ability to use a computer.

Avoiding Obsolescence

ES.9

A serious and quite legitimate concern of many administrators faced with the task of choosing and purchasing sophisticated computer hardware and software is the rapidity with which such equipment regularly becomes obsolete. The all-too-frequent response to concerns about obsolescence or seductive rumors about what's "just around the corner" often results in an endless series of postponements to the establishment of adapted computer technology on campus.

There are two distinct types of obsolescence: technological and functional. Technological obsolescence is a research driven phenomenon which generally provides a better way to do an existing task. One solution to the issue is simply to accept the periodic technological obsolescence of existing adaptations as a part of the cost of doing business. Advances in adapted computer technologies sufficient to warrant replacement occur

approximately every three years or so if previous cycles of improvement are reliable indicators. Functional obsolescence is task related. A wrench is the ideal tool for the task of loosening or tightening a nut. If, however, the nut is replaced by a rivet, the wrench becomes functionally obsolete.

Although technological obsolescence seems unavoidable, careful initial planning can forestall an adapted computer device's functional obsolescence for many years. By providing effective, generalized access to campus computer facilities, the basic tasks which must be accomplished to complete a post-secondary educational program will be within the grasp of disabled students. Basic educational tasks, unlike technology, change very little from year to year. The effectiveness with which disabled students are able to use these adaptations to complete academic tasks will have a direct bearing on the functional life expectancy of such equipment. The more effectively an adaptation meets a need, the longer it can be used.

ES.10

Computer Access, Disability and the Law

As new technologies are introduced into the marketplace and become commonplace in post-secondary education, the challenge to accommodate disabled students is presented to colleges and universities on a daily basis. Many new adapted computer technologies clearly do not place an undue financial burden or hardship on an institution. The issue is how to quickly and easily make it possible for students with disabilities to take advantage of these new technologies.

Not only do colleges and universities have a historical commitment to providing a comprehensive education to all matriculating students, but legal re-

quirements exist which mandate that institutions provide equal access to educational opportunities for students under the Civil Rights Act of 1964 and, more specifically, under Section 504 of the Rehabilitation Act of 1973 as amended [29 U.S.C. sec. 794]. This Act describes "reasonable accommodation" as the method for ensuring the nondiscrimination of disabled persons. Across the country, institutions have taken broad steps to make education more accessible to students with disabilities. The decade of the 1970's saw great emphasis on the removal of architectural barriers on campuses so that students in wheelchairs could get into classrooms. Elevators were built so that physically handicapped students could access classrooms on the second or third floors of campus buildings and attend class. States now have Architectural Review Boards and extensive requirements for the construction of buildings and pathways which accommodate the disabled as a general rule. Reflecting on what was built in the past, how could our planning have been so shortsighted as to have constructed engineering centers or humanities laboratories from which students with physical disabilities were barred by oversights in design?

ES.II

Now that adapted computer technology, based primarily in software, permits full access to commercially available and professor-authored software programs, individual microcomputers and networks, it is reasonable to expect institutions to take proactive steps to accommodate students with disabilities. There can and most certainly will be legal consequences in not doing so, as equal access and equal opportunity continue as guiding principles in college admissions and academic participation.

As a case in point, in the 1979 Supreme Court case *Southeastern Community College v. Davis*, our highest court recognized emerging needs of the disabled in terms of advances in technology:

We do not suggest that the line between a lawful refusal to extend affirmative action and illegal discrimination against handicapped persons will always be clear. It is possible to envision situations where an insistence on continuing past requirements and practices might arbitrarily deprive genuinely qualified handicapped persons of the opportunity to participate in a covered program. Technological advances can be expected to enhance opportunities to rehabilitate the handicapped or otherwise to qualify them for some useful employment. Such advances also may enable attainment of these goals without imposing undue financial and administrative burdens upon a state. Thus, situations may arise where a refusal to modify an existing program might become unreasonable and discriminatory. Identification of those instances where a refusal to accommodate the needs of a disabled person amounts to discrimination against the handicapped continues to be an important responsibility of HEW [442 U.S. at 412-413].

ES.12

Further, in *Alexander v. Choate* [105 S.Ct. 712 (1985)], the Supreme Court states:

Discrimination against the handicapped was perceived by Congress to be most often the product not of invidious animus, but rather of thoughtlessness and indifference-of benign neglect ... For example, elimination of architectural barriers was one of the central aims of the Act, yet such barriers were clearly not erected with the aim or intent of excluding the handicapped [105 S. [Ct.at](#) 718-19].

Looking ahead to the year 2000, it is essential that we consider reasonable accommodation as a regular part of institutional planning. Returning now to adapted computer technology, responding to the microcomputer onslaught in the college classroom and campus environment, simple steps can be taken to en-

sure that students with disabilities can use microcomputers as an ongoing part of their college education. In many cases, accommodation is simple. What can institutions do? First, in planning microcomputer and mainframe use at an institution, consider that an ongoing portion of students will need to be reasonably accommodated due to visual, physical, hearing or learning disabilities. Design an accessible system. Next, keep abreast of software packages that permit reasonable accommodation for the disabled and allow non-disabled persons access as well. Third, it is critical that institutions pay particular attention to how public information is made available to the campus and at-large community and, wherever public information is available, ensure that persons with disabilities have access to this information as equal members of the college community. For example, if students are required as part of the college curriculum to access LEXIS, DOW JONES or ERIC databases, questions such as "how will a blind student use this terminal" or "is the library's computer which contains ERIC accessible to a student in a wheelchair" must be answered. If all students at an institution are given a microcomputer or are required to use ones available in the campus center, student lounge or dormitory, how will disabled students be accommodated? Adapted computer technologies provide answers to these questions and enable institutions to provide the very best through hardware and software accommodations that are becoming increasingly commonplace.

ES.13

Finally, in relating these emerging new technologies to the goals and objectives of affirmative action, Section 504, and the U.S. Department of Education's regulations on Section 504 in regard to program accessibility and the provision of auxiliary aids to students with disabilities (34 C.F.R. Part 104), standards have now been developed which apply to adapted computer

technologies. Quoting from a recently released report produced jointly by the Department of Education and the General Services Administration:

On October 21, 1986, the Department of Education (ED) and the General Services Administration (GSA) were directed by Congress (Public Law 99-506) to develop agency procurement guidelines to ensure access to electronic office equipment by individuals with disabilities.

The report continues:

In 1986, Congress re-authorized the Rehabilitation Act of 1973, as amended, (Public Law 99-506) adding Section 508 on electronic equipment accessibility "... to insure that handicapped individuals may use electronic office equipment with or without special peripherals." Congress has mandated that guidelines for electronic equipment accessibility be established and adopted and that agencies shall comply with these guidelines with respect to electronic equipment, whether purchased or leased.

ES.14

These clearly defined access criteria, usage requirements, guidelines and related access issues comprise standards which will, in short order, become law or administrative rulings. Applying the likelihood of this kind of legislation to the needs of disabled persons, it is probable that institutions which receive federal funds and which require computer access for all students will need to prepare for such standards very soon.

Future Trends and Issues

New trends in academic computing hold both promise and peril for disabled students in post-secondary edu-

cation. In order to better manage existing computer resources, many colleges are developing networked systems which link a wide range of micro, mini and mainframe computers into a single cohesive system. The benefits of such systems can be enormous: common access to electronic mail, research databases, centralized word processing, computer assisted instruction, course registration and library resources, to name a few. An alarming factor in this rush for control and management of burgeoning computer resources is the limited amount of consideration given to the impact of such networks on computer access for disabled students. A number of considerations must be taken into account when such systems are under consideration:

How will networking software affect existing computer adaptations?

If centralized word processing is to be introduced, will the system employ screen formats which can be accessed by systems for blind computer users?

If terminals rather than PC type microcomputers are the primary workstations, how will access for low vision, blind and orthopedically disabled students be provided?

ES.15

These are but a few of the questions which must be carefully considered when planning the installation of such systems.

With the advent of high resolution color displays and laser disk technologies, all indications point to a growing emphasis on graphically oriented computer displays. This could have significant adverse impact on visually impaired individuals. The Apple Macintosh computer is a classic example of a state-of-the-art graphically oriented computer system, which, until

recently, was totally inaccessible to blind computer users. The bit-mapped screen displays could not be read by any existing systems for blind computer users; the mouse interface was entirely dependent on visual orientation. The icon based system commands were graphically rather than textually configured and could not be interpreted by previous screen reading systems. It is now well within the range of technological possibility to design such systems with the means to support adaptations for blind users. However, such design considerations must be incorporated into the basic architecture of the system, not added on at a later date. As more and more sophisticated computer systems are developed, awareness of access requirements for disabled computer users during the early design phases of such machines will become progressively more critical.

ES.16

Computerized versions of most major placement tests are now available or being actively developed by large testing companies. If, and we have no reason to believe otherwise, computer based testing becomes the national norm, how will computer access be provided to disabled individuals wishing to take such tests?

Much vital, public information now only exists electronically in massive, federally funded computer databases. With such databases rapidly becoming the exclusive domain of vast quantities of public information, are they not, in fact, a new kind of public library? If they are, in fact, public libraries dependent upon federal funds, then they must be readily accessible to all citizens, including disabled citizens, under Section 504 of the Rehabilitation Act of 1973. How will such access be provided?

Obviously, questions of enormous magnitude remain to be answered in the decade ahead. The opportunities for disabled individuals to succeed in our technologically advanced society have never been greater.